Re-blessing: Study of ttbar Production Mechanisms

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Analysis Overview

Changes to the previously blessed results

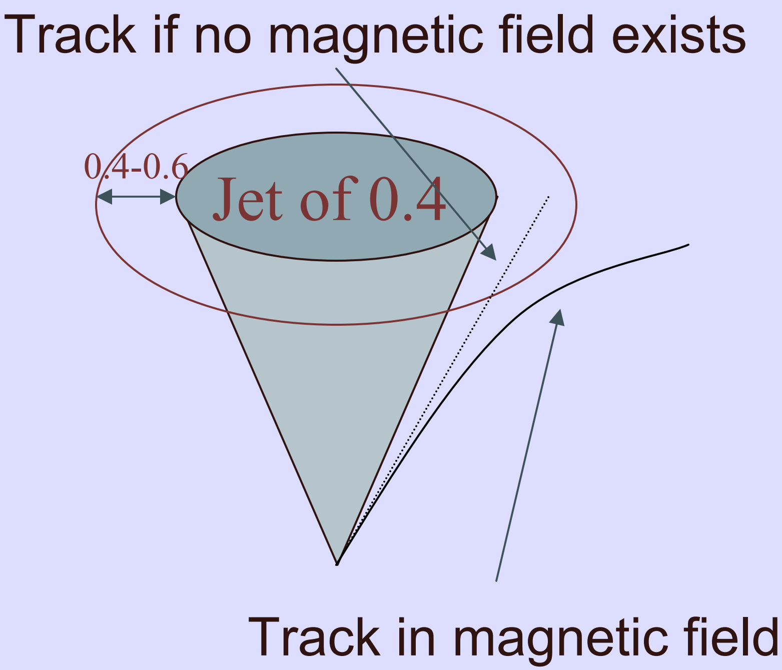
Plots and Results to Bless

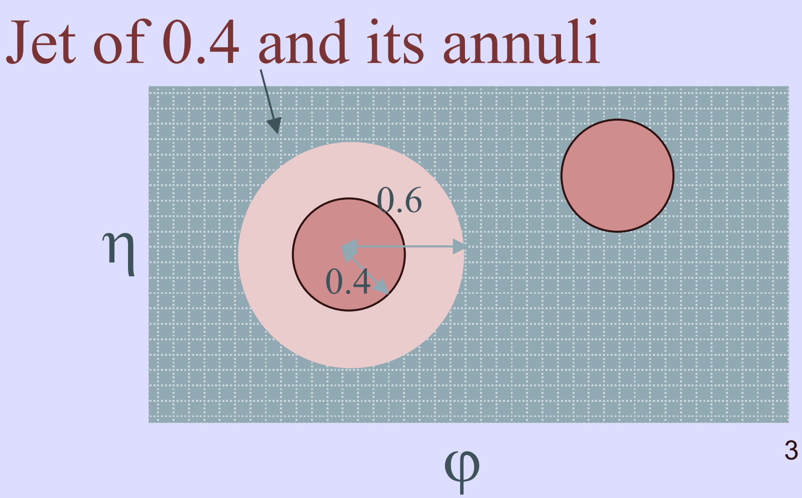
Analysis Overview I

- The goal is to measure $\sigma_{(gg \to t\bar{t})} / \sigma_{(p\bar{p} \to t\bar{t})}$
  - ✓ Test of pQCD
  - ✓ High x gluon distribution
  - ✓ Unknown sources of physics beyond the SM
- Low pt track multiplicity
- Data-driven method
- Dijet and W+n jet samples as calibration

Track multiplicity

- defTracks
  - ✓ p_T 0.3 – 2.9 GeV/c^2
  - ✓ $|\eta| \leq 1.1$
- Matched to the event vertex
  - ✓ 3cm
- Away from jets
  - ✓ ΔR=0.6, $corE_T \geq$15 GeV
  - ✓ ΔR=0.4, 6 $\leq corE_T <$ 15 GeV
- Correct for area differences
- Correct for remaining contribution of high E_T jets
  - ✓ 0d: 0.90 $\pm$ 0.03
  - ✓ 0h: 0.97 $\pm$ 0.04
  - ✓ 0i: 0.96 $\pm$ 0.04



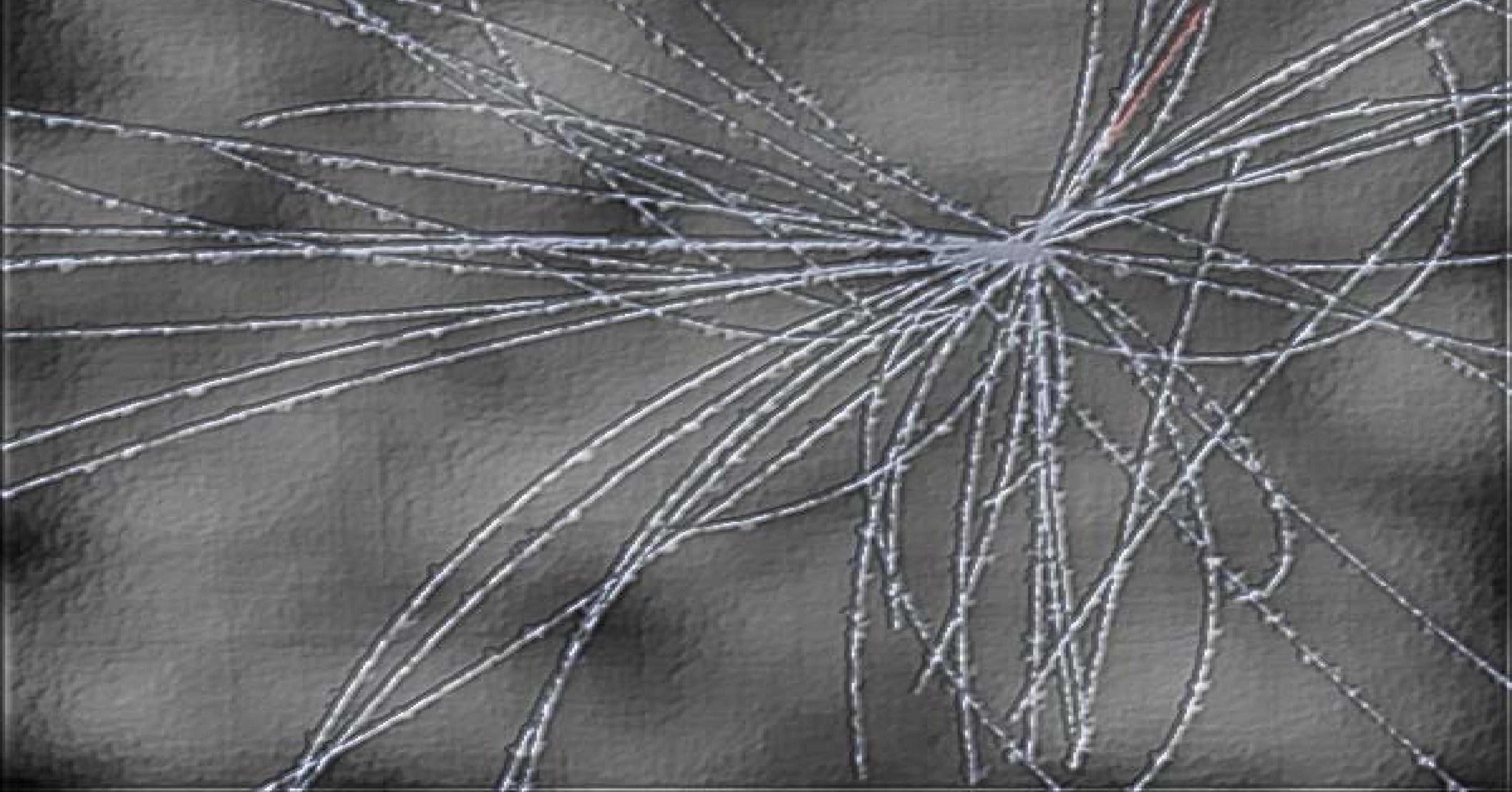


Analysis Overview II

- Correlation between <N_{trk}> and <N_g>
  - ✓ MC calculations to find <N_g> in a sample
- W+0 jet sample, almost purely qq
- dijet sample with leading jet Et of 80-100 GeV, large gluon content
- Binned likelihood fit with two free parameters

$$N\,[\,f_g F_g^{norm} + (1 - f_g) F_q^{norm}\,]$$

Changes to the Previously Blessed Results



Changes in W+n jet/ttbar event selection

- Bugs that are fixed
  - ✓ TCEM, TCMUP and TCMX triggers had been assumed to be fired
    - 8 TCMUP ttbar candidates
  - ✓ For the tight jets, the event η was used instead of the detector η.
    - 3 ttbar candidates
- QCD rejection cut
  - ✓ We had required $\Delta\varphi$ of the missing Et and the leading tight jet to be between 0.5-2.5 rad, if missing Et < 30 GeV
    - To be consistent with the background estimates, we removed it. 16 ttbar candidates
- Now observe 240 tagged lepton+jet ttbar candidate events, instead of 229.

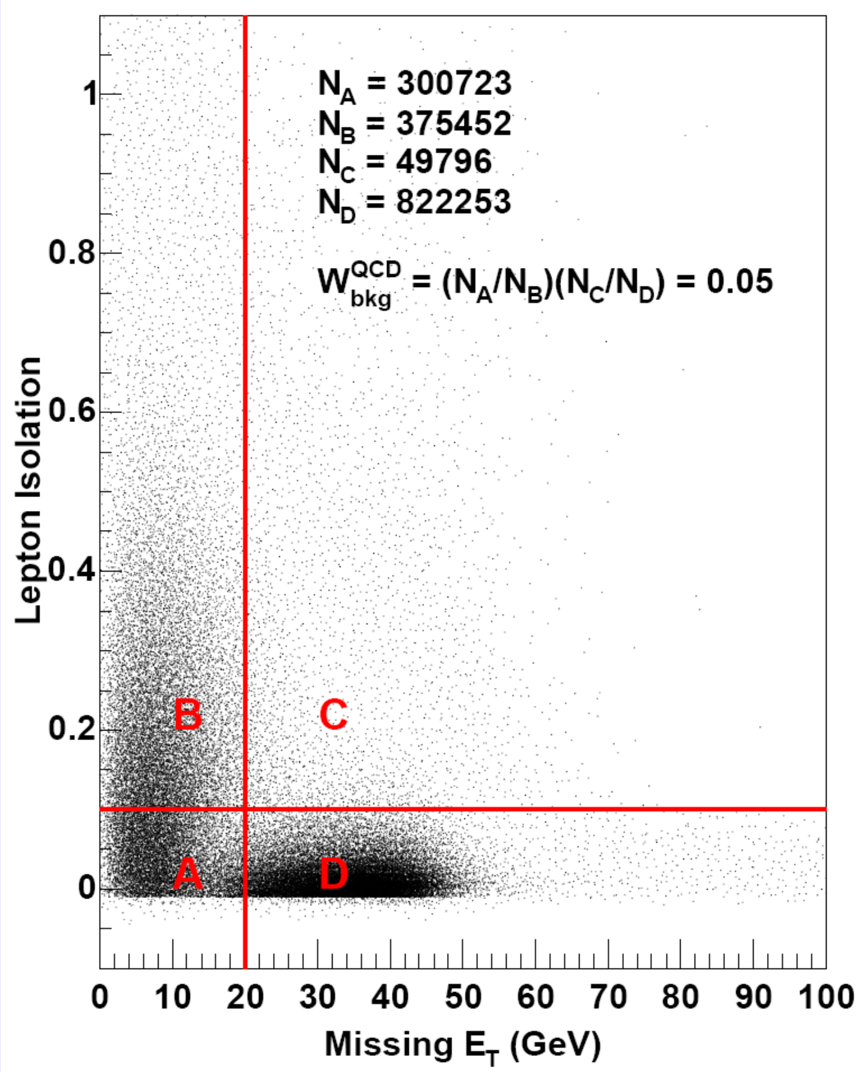
QCD background in W+0 jet

- Previously estimated 1% had assumed W mass constraint, we do not and so now estimate it to be

$N_D^{bkg}/N_D = (N_A/N_B)(N_C/N_D) = (4.9 \pm 0.4)\%$

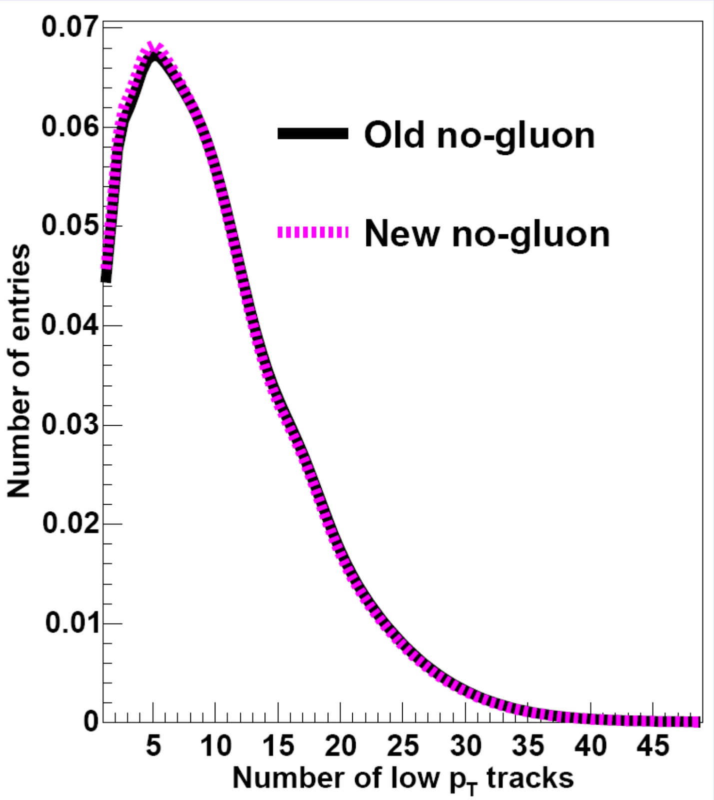
- Electrons and muons are different separately, use for systematic uncertainties

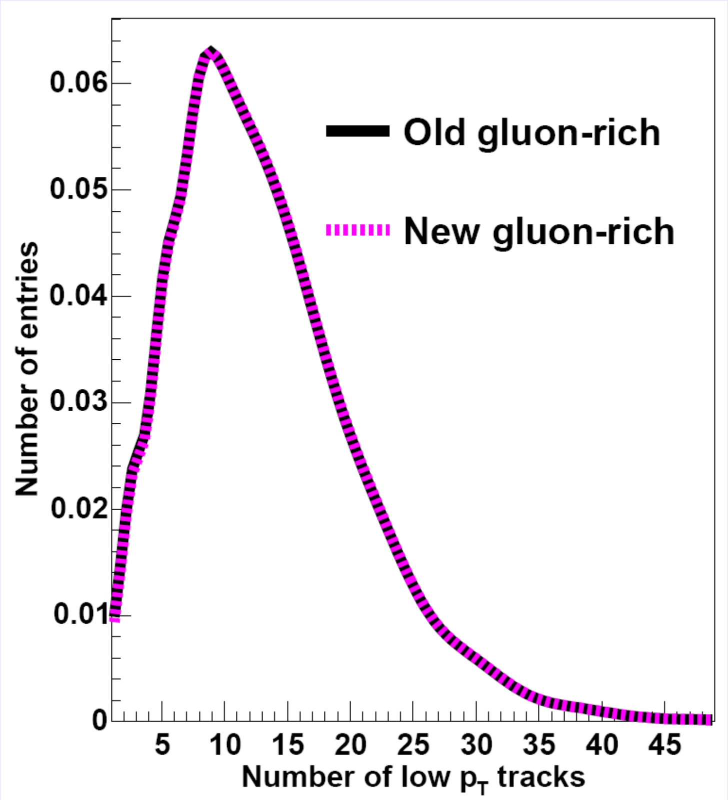
- Gluon-content change by less than 0.5%



Effects and implications…

- Negligible change in parameterizations.
- Bugs and W+0 jet QCD background has negligible effects.
- Removing QCD veto is important as previously we were double-counting background.
- Use previous systematics
  - ✓ checked W+0 gluon composition, no change.

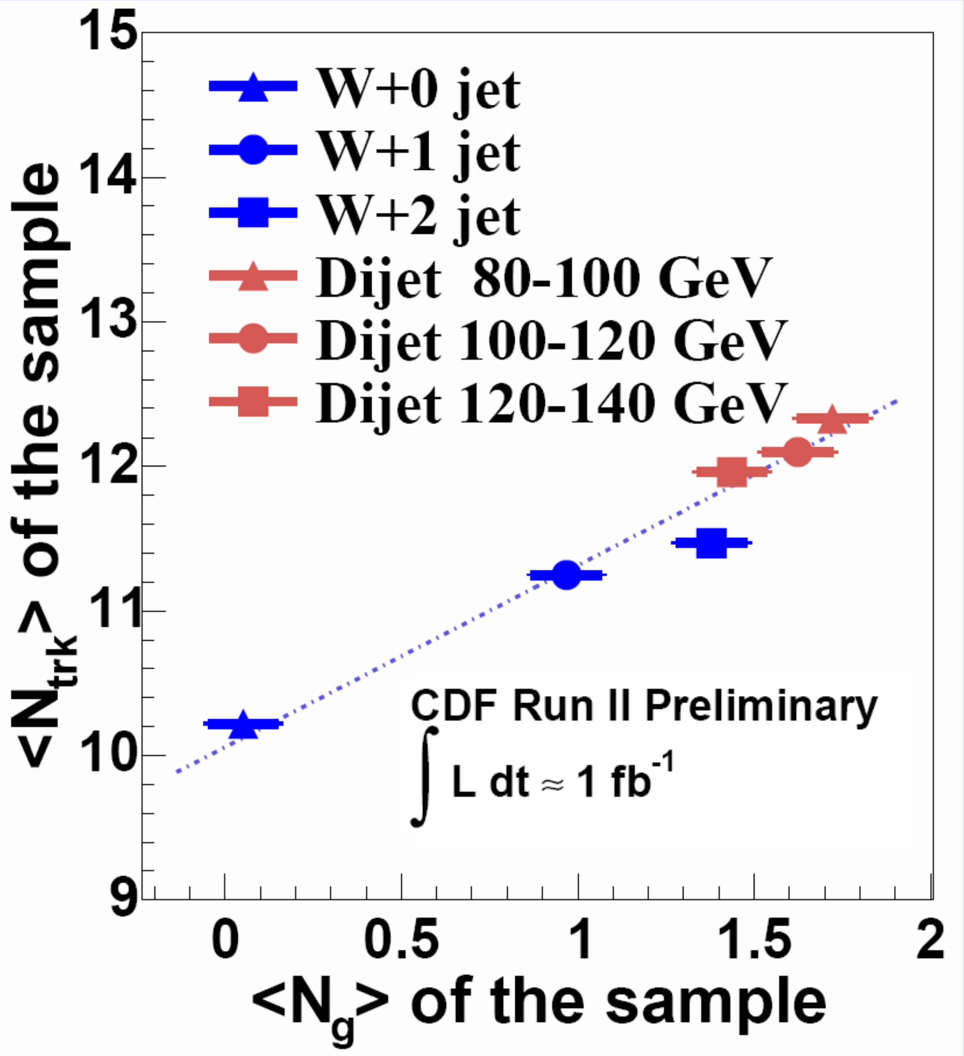




Plots and Results to Bless…

Correlation between $<N_g>$ and $<N_{trk}>$

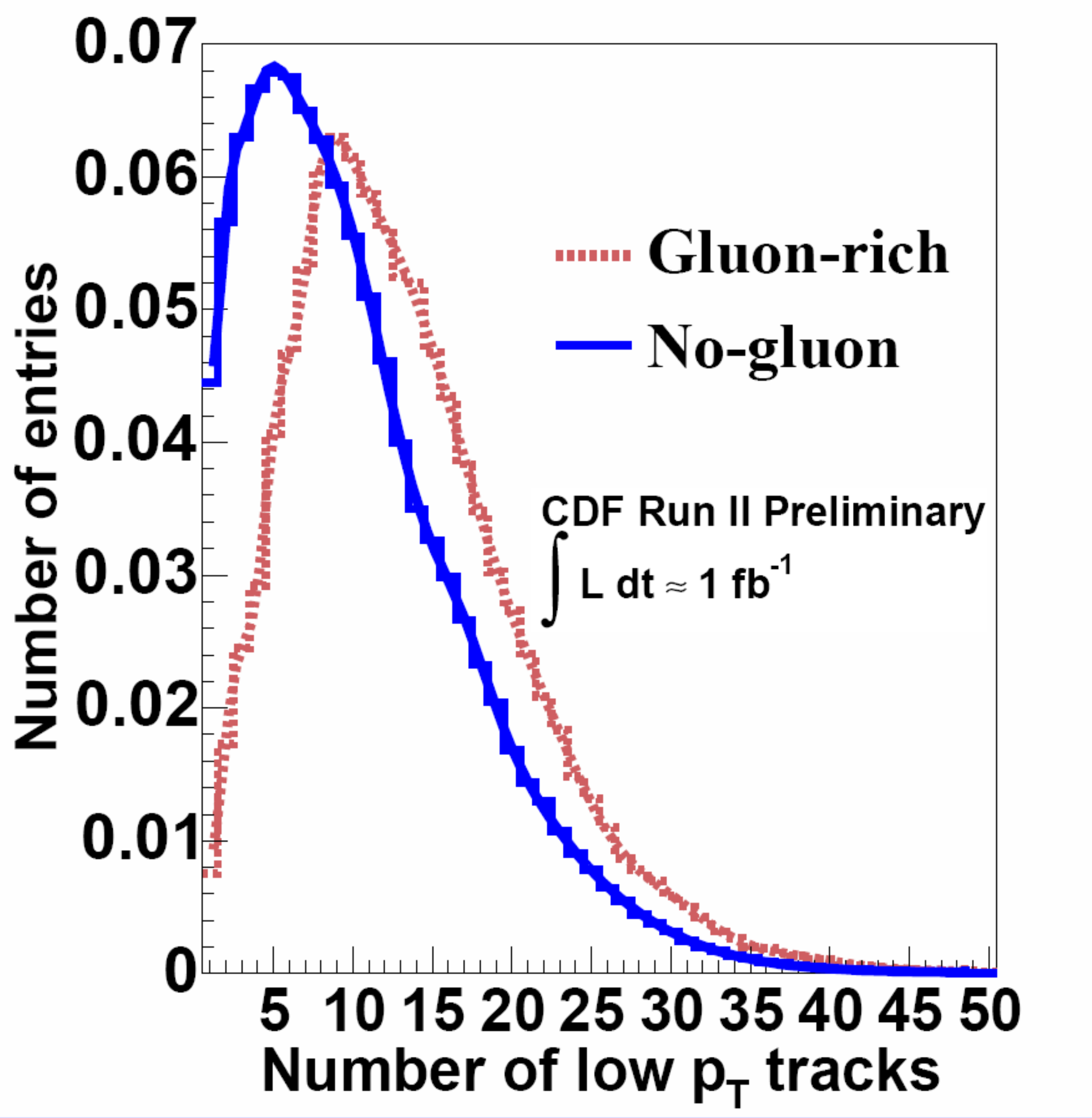
Sample	MC $<N_g>$	Data $<N_{trk}>$
W+0 jet	0.05 ±0.10	10.22±0.01
W+1 jet	0.97 ±0.10	11.25 ±0.03
W+2 jets	1.38 ±0.10	11.47 ±0.06
80-100 GeV	1.72 ±0.10	12.33 ±0.02
100-120 GeV	1.62 ±0.10	12.10 ±0.02
120-140 GeV	1.44 ±0.10	11.96 ±0.04



using the fit to find $<N_g>$ for other samples $<N_{trk}>$

Sample	MC prediction	Fit result
140-160 GeV	1.26 ±0.04	$1.39^{+0.06}_{-0.05}$
160-180 GeV	1.13 ±0.04	1.23±0.05
180-200 GeV	0.99 ±0.07	$1.08^{+0.05}_{-0.06}$
200-220 GeV	0.92 ±0.10	$0.88^{+0.04}_{-0.07}$
220+ GeV	0.67 ±0.10	$0.65^{+0.05}_{-0.10}$

Parameterization



Fit and MC values for different calibration samples

Sample	f_g *from the fit*	MC prediction
80-100 GeV	0.734 ± 0.004	0.73 ±0.02
100-120 GeV	0.688 ± 0.005	0.69 ±0.02
120-140 GeV	0.659 ± 0.010	0.63 ±0.03
140-160 GeV	0.627 ± 0.005	0.57 ±0.03
160-180 GeV	0.573 ± 0.005	0.52 ±0.03
180+ GeV	0.492 ± 0.005	0.42 ±0.05

Estimating gluon-rich fraction in background

Sample	f_g - no tag	f_g - tagged
W+1 jet	0.41 ± 0.01	0.56 ± 0.05
W+2 jet	0.51 ± 0.02	0.42 ± 0.08
W+3 jet	0.56 ± 0.04	0.44 ± 0.12
Extrapolated W+4$^+$ jet, (f_g^{LF}) (f_g^{HF})	0.72 ± 0.05	0.27 ± 0.19
LF fraction in background (f_b^{LF})	-	0.55 ± 0.11
HF fraction in background (f_b^{HF})	-	0.45 ± 0.09

- We calculate f_g^{bkg} assuming Gaussian distributions for the variables used in the following equation using the above values

$$f_g^{bkg} = f_b^{LF} f_g^{LF} + f_b^{HF} f_g^{HF}$$

- We find $f_g^{bkg} = 0.53 \pm 0.09$ (modeling) $\pm\ 0.09$ (nonW HF/LF composition)

- HF background is anything that can have a real tag (Wc, Wcc, Wbb, Single Top and half of nonW) and the rest is what we consider LF

gg and qq to ttbar Acceptance

	gg→tt, ≥4 jets	qq→tt, ≥4 jetsUpdated
Updated A_{tagged}	0.141 ±0.005	0.115 ±0.004
Previous A_{tagged}	0.099 ±0.003	0.088 ±0.003

Used ttop75 PYTHIA MC Sample

Systematic uncertainties-I

- Uncertainties affecting track multiplicity
  - ✓ Change the central values and observe the changes in relevant variables

	f_g	f_g^{bkg}
Track/jet correction	±0.051	±0.001
Low jet E_T cut	±0.021	±0.035
Dijet qq→qq fraction	±0.002	±0.019
W+0 jet f_g	±0.039	±0.007
nonW LF/HF composition	-	±0.057
Modeling the f_g^{bkg} distribution	-	±0.089
Total	±0.07	±0.11

Systematic uncertainties-II

- Uncertainties due to f_g, f_g^{bkg} and f_b

	f_g^{tt}
f_g	± 0.08
f_g^{bkg}	± 0.02
f_b	± 0.01
Total	± 0.08

Systematic uncertainties-III

- Uncertainties due to f_g^{tt} and acceptances

	$\sigma(gg \to tt)/\sigma(pp \to tt)$
f_g^{tt}	± 0.067
$\mathcal{A}_{gg \to tt}/\mathcal{A}_{qq \to tt}$	± 0.004
Total	± 0.07

Result

- Using the fit result

$$f_g^{W+\geq 4} = 0.15 \pm 0.14(stat) \pm 0.07(syst)$$

- and the values we found, and a background fraction of (13 ± 2)%, we get

$$f_g^{tt} = 0.09 \pm 0.16(stat) \pm 0.08(syst),$$

- and using $\mathcal{A}_{gg\to tt}/\mathcal{A}_{qq\to tt}$ = 1.23 ± 0.06, we find

$$\frac{\sigma(gg \to t\bar{t})}{\sigma(p\bar{p} \to t\bar{t})} = 0.07 \pm 0.14(stat) \pm 0.07(syst)$$